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DERWENT-WEEK: 200404

TITLE: Pile construction equipment and method for piling through an unstable upper soil layer in which a casing surrounding an auger is coupled and uncoupled during auger rotation and coupled again during auger removal

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APPLICATION-DATA:

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INT-CL (IPC): E02D005/36

ABSTRACTED-PUB-NO: GB 2355750A

BASIC-ABSTRACT:

NOVELTY - The auger (14) is mounted on a mast (12) and the casing (25) is mounted around the auger and prevented from rotating by reaction plates (27). The auger to casing coupling includes a ring bearing (32) between two flanges (28,31) that allows a casing upper assembly (29) to rotate. A pin is inserted in the flanges to lock the assembly and casing as required. The assembly has mounting apertures (36) attached to sockets on the auger flight (16) by bars (37) held by pins.

USE - For constructing a pile in ground with an upper soil layer which is unstable relative to the underlying strata using continuous flight auger (CFA) methods in which the auger is rotated by a driving unit that moves up and down the mounting mast.

ADVANTAGE - The casing prevents soil collapse into the pile during auger rotation and removal. The casing is removed as the auger is withdrawn and concrete is pumped through the auger shaft. Provides an improved technique for inserting and removing casings compared with piling using a separate casing installation operation or CFA piling equipment using duplex drilling, i.e. casing rotation counter to auger rotation.

DESCRIPTION OF DRAWING(S) - The drawing shows a detailed view of the pile construction equipment in the area of the auger to casing coupling.

Mast 12

Auger 14

Auger flight 16

Casing 25

Reaction plates 27

Flanges 28,31

Casing upper assembly 29

Ring bearing 32

Mounting apertures 36

Bars. 37

CHOSEN-DRAWING: Dwg.2/3

TITLE-TERMS: PILE CONSTRUCTION EQUIPMENT METHOD PILE THROUGH UNSTABLE UPPER
SOIL LAYER CASING SURROUND AUGER COUPLE UNCOUPLE AUGER ROTATING
COUPLE AUGER REMOVE

DERWENT-CLASS: Q42

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Non-CPI Secondary Accession Numbers: N2001-229791

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E02D 5/36

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EPODOC,WPI,JAPIO

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(54) Abstract Title
Forming piles

(57) A method is for forming piles through soil having an unstable upper layer. This is achieved by having a casing that can be coupled and uncoupled from an auger. The coupling arrangement is such that the casing does not rotate with the auger but rather is restrained to move along a straight line. Thus, during initial drilling the auger and casing are coupled together. This means that the casing is pushed into the soil until it has travelled through the unstable layer. The auger is then stopped and the casing uncoupled from the auger which is then allowed to complete the drilling to the required depth. Concrete is then pumped through the shaft of the auger as the auger is removed. When the auger reaches the point where it had been disengaged from the casing, pumping of concrete is stopped and the casing is reengaged with the auger. Withdrawal of the auger and pumping of the concrete is then restarted.

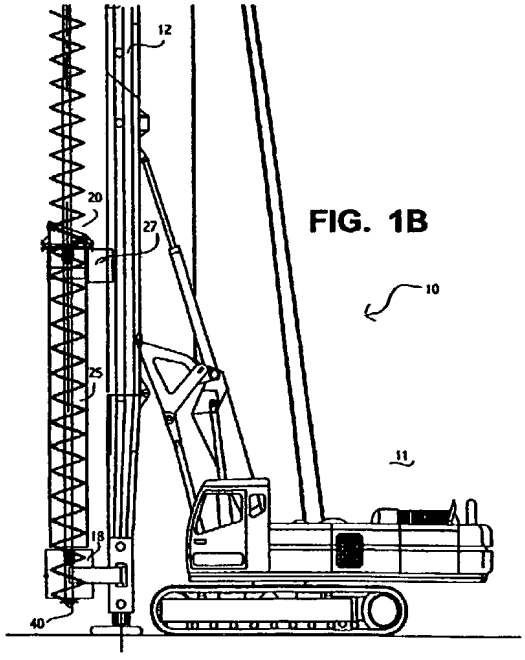

FIG. 1B

GB 2 355 750 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

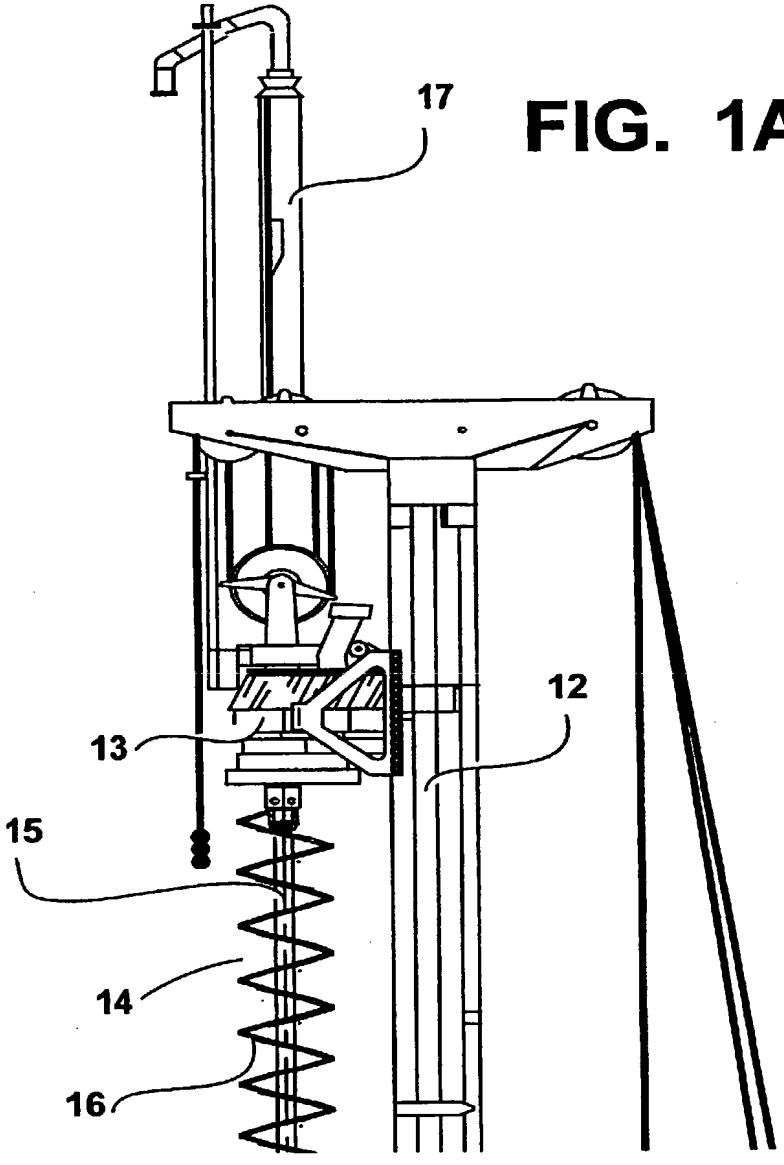

FIG. 1A

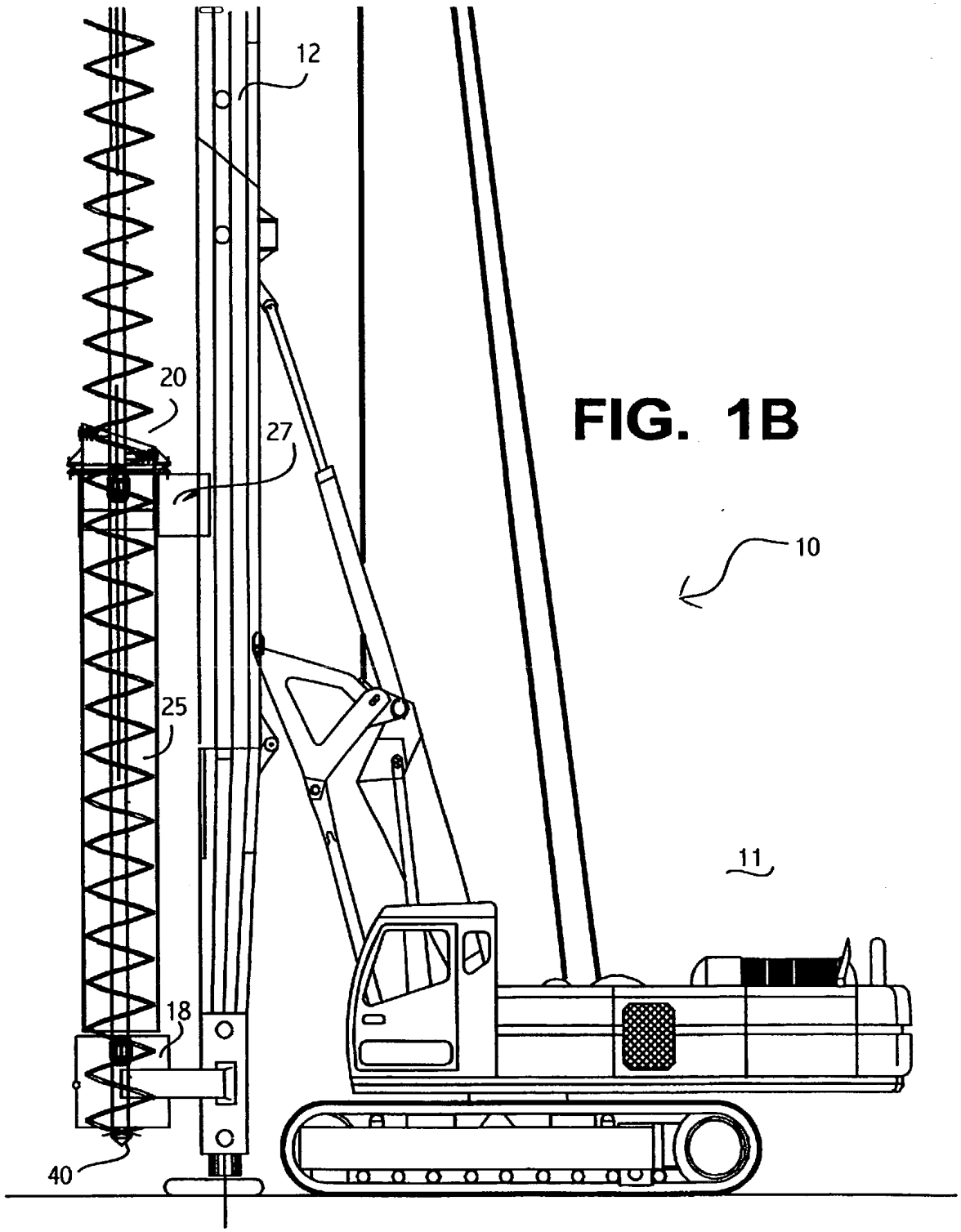

FIG. 1B

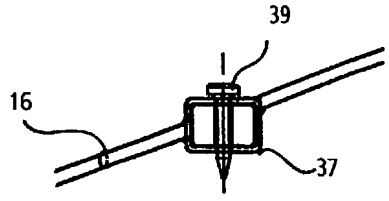
39
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FIG. 3

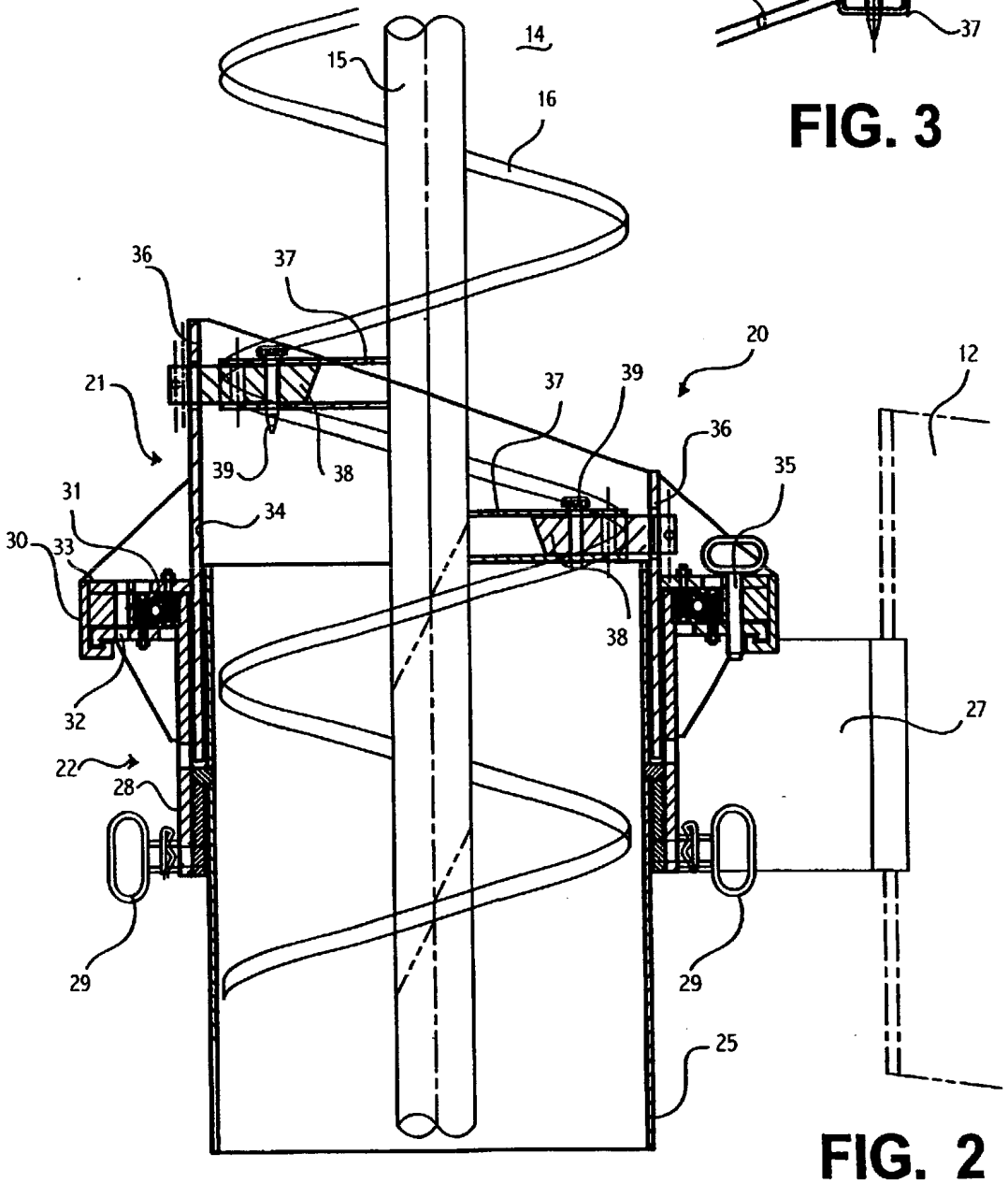
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FIG. 2

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Forming Piles

The present invention relates to forming piles using continuous flight auger (CFA) methods, and more specifically to forming piles in ground having an upper layer which is relatively weak in comparison to the underlying strata.

A standard technique for forming a CFA pile is to screw the auger to founding depth without forming an empty bore. The auger is fitted with a blade or flight which spirals helically around a hollow shaft, for the full length of the auger. The hollow shaft is used to pump concrete to the base of the auger, immediately filling the pile section while the auger is being withdrawn. A positive pressure and an excess concrete flow rate are maintained, to ensure that the pile section is completely filled with concrete. After the auger has been fully withdrawn, reinforcing elements can be inserted into the concrete before it sets if required. (The term 'concrete' is used here to describe concrete, mortar, and other cementitious mixtures containing also aggregate, water, and possibly admixtures.)

The flights on the auger terminate just above its boring head. Conventionally the diameter of the boring head is slightly greater than the flight auger above it. The base of the boring head is fitted with one or more cutting edges, teeth or picks, which cut into the soil as the auger rotates.

While the auger is being screwed into the soil, some of the soil displaced (by the self volume of the auger) is carried up the flight of the auger to the surface of the ground, where it is removed.. The spoil is carried up the auger flight by a combination of physical phenomena - the pressure of additional spoil which is created as the auger screws deeper into the soil, the rotation of

the flight of the auger and the interaction with the undisturbed soil around the side of the pile. The auger flight will normally be relatively fully loaded with spoil, with only the excess being released at ground level.

The resistance which the soil presents to the auger will of course depend on the nature of the soil. When the soil exhibits very low resistance, the auger will screw into the ground at a rate corresponding to the pitch of its flight. However, particularly in competent cohesive soils, it is known that if the auger is allowed to descend at its pitch rate, the spoil in the flight can become densely packed. In this circumstance the spoil does not travel up the flight, and thus prevents the auger screwing further into the soil. The rate of advance of a CFA is therefore normally controlled to be less than the full pitch rate.

As already mentioned, the resistance which the soil presents to the auger depends on the nature of the soil. In many circumstances the upper (i.e. near ground level) levels of soil will be of a weaker nature than the underlying soils. In these instances when the boring head reaches a more competent strata, the rate of advance will be less than that applying at the upper layers.

For the construction of bored piles, it is standard practice to install a length of temporary casing, to provide a safe working environment and also to re-locate the boring tool after each successive boring increment. In contrast, CFA piles are conventionally constructed without the use of any temporary casing.

However, in certain circumstances it may be desirable to install a length of temporary casing for the construction of CFA piles. In particular, if the upper layers of soil are weak or loose, the rotation of the auger can cause this material to be transported to the surface, dragging further material on to the auger from the walls of the pile. This is undesirable for various obvious

reasons. To counteract this, a suitable length of casing may be inserted into the soil prior to the flight auger boring the pile. Conventionally the casing is removed after the auger has been fully withdrawn, although if required it may be left in place.

In the past, when the use of a temporary casing has been required for CFA piles, the installation of that casing has generally been carried out as a separate operation. Exceptionally, however, special equipment is available whereby a casing can be installed in a single operation, i.e. with the CFA piling equipment. This type of installation is termed 'duplex drilling', and requires the use of a separate motor to rotate the casing in the opposite direction to the auger. This type of special equipment is costly. Moreover, the additional weight at the front of the piling rig can give cause for concern regarding the stability of the rig.

The general objective of the present invention is to provide an improved technique of inserting and removing such casings.

According to one aspect, the invention provides a method of constructing a pile in soil having an unstable upper layer by installing into the soil an auger having a continuous flight and a hollow central shaft and inserting into the soil a casing which is held against rotation as the auger is rotated, and then removing the auger while pumping concrete through its shaft, wherein the casing is coupled at its top end to the auger for lowering through the unstable soil layer and then uncoupled therefrom.

In a preferred form, the invention provides a method of satisfactorily constructing a CFA pile in soil having an unstable upper layer by using the CFA rig to install a length of casing at the beginning of the construction of the CFA pile. The casing is attached to the auger by means of two or more

removable locking bars. These locking bars are interlocked with a short 'head' section of casing, and they cause this section to rotate with the auger. The head section is connected to the main casing by means of a ring bearing. The main casing is prevented from rotating (while the auger is screwed into the ground) by means of one or more reaction arms, which react onto a fixed part of the CFA rig, e.g. the mast. After the casing has been installed to a predetermined depth, the locking bars (connecting the head section to the auger) are removed and the ring bearing (between head section and main casing) is then locked. The auger is then screwed to depth in the normal manner. During the concreting phase the auger is withdrawn as normal, while pumping concrete through its shaft. The casing may then be removed from the ground by means of a separate lifting facility (service crane, etc). Preferably, however, during the concreting phase, when the auger has been withdrawn to a height where the locking bar fittings coincide with those on the head section, the casing is re-attached to the auger. The concreting phase is then re-commenced, and the casing is then removed with the auger.

According to another aspect, the invention provides pile forming apparatus comprising an auger, a casing surrounding the lower end of the auger, a coupling device mounted at the top of the casing via a ring bearing, and means for attaching the coupling device to the auger.

Pile forming machinery in accordance with the invention and for performing the method of the invention and its method of operation will now be described, by way of example, with reference to the drawings, in which:

Figs. 1A and 1B together are a general view of the machinery;

Fig. 2 is a more detailed view of the auger and associated components; and

Fig. 3 is a detailed view of a part of the auger flight.

Figs. 1A and 1B show pile forming machinery 10 consisting of a crawler unit 11 carrying a mast or column 12. The mast 12 has mounted on it an auger driving unit 13 which carries an auger 14. The driving unit 13 includes a motor for rotating the auger 14, and can also move itself up and down the mast. The auger passes through a guide collar 18 mounted on the bottom end of the mast 12. The auger 14 consists of a hollow central shaft 15 around which a continuous blade or flight 16 is attached, and may be formed from a number of sections bolted together. The mast 12 carries concrete supply tubing 17 at its top end, coupled to the top end of the auger shaft by flexible tubing (not shown). During construction of the pile , the unit 13 rotates the auger and is lowered as the auger is screwed into the ground. When the auger has reached the desired depth, the unit 13 pulls the auger up out of the hole (with or without rotation). While the auger is being withdrawn from the pile, a pump (not shown) pumps concrete down the hollow shaft 15 to fill the section vacated by the auger, thus forming the pile.

A casing 25 is mounted round the auger 14 and coupled thereto by a coupling 26. The upper end of the casing is fitted with reaction arms or plates 27 which can slide freely up and down the mast 12 but restrain the casing 25 from rotation.

The coupling 26 is shown in more detail in Fig. 2. The upper end of the casing 25 is welded to a sleeve 27 with a flange 28. Above this, an upper assembly 29 comprises a sleeve 30 with a flange 31 as shown. Between the two flanges 28 and 31 there is a ring bearing assembly 32 which allows the upper assembly 29 to rotate relative to the casing. The auger 14 passes axially through the sleeve 30 of the upper assembly 29. The sleeve 30 descends into the upper end of the casing 25 as shown and abuts against an inner sleeve 29, welded to the main casing 25, to protect the bearing 32 from spoil being carried up by the auger.

The flanges 28 and 31 have holes through which a pin 34 can be inserted to lock the upper assembly 29 to the casing if desired. The detail of this locking assembly is not critical to the function of the equipment. Flange 31 may have a single hole; flange 28 may have a series of holes around it so that the upper assembly can be locked to the casing with only minor adjustment of its position regardless of its angular position relative to the casing.

The sleeve 30 of the upper assembly 29 has two mounting apertures 36 in it as shown, diametrically opposite each other and vertically offset by half the pitch of the auger flight 16. The auger flight 16 has attached to or formed in it a pair of sockets 35; as shown in Fig. 3, the sockets are preferably located generally beneath the upper surface of the flight. Additional sets of sockets may be fitted at other levels of the auger flight. A pair of bars 37 can be inserted through the mounting apertures 36 of the upper assembly 29 and into the sockets 35 on the auger, so locking the upper assembly 29 to the auger. A pair of pins 38 can be inserted through the sockets 35 and bars 37 to hold the bars in place.

To form a pile in soil with an unstable upper layer, the pile forming machinery is assembled as shown, with a casing 25 around the auger 14. The length of the casing is chosen to be at least as great as the depth of the lower boundary of the unstable layer of soil. To ensure that the casing will be drawn down by the auger, the position of the casing 25 is adjusted so that the boring head 39 of the auger 14 protrudes a short distance beyond the bottom end of the casing.

Before drilling starts, the upper coupling assembly 29 is locked to the auger 14. As drilling is started and proceeds, this upper assembly will rotate with the auger, and be carried down as the auger penetrates the soil. The

casing 25 is held against rotation, but is forced down the hole by the upper assembly 29, which presses on the upper end of the casing via the ring bearing assembly 32. The casing 25 therefore lines the hole and prevents ingress of soil from the unstable layer.

When the hole has passed through the unstable layer of soil, the drilling is interrupted and rotation of the auger is stopped. The upper coupling assembly 29 is now disengaged from the auger, by withdrawing the bars 37, and locked to the casing 25 by inserting the pin 34. Drilling is then restarted. The casing 25 is, as before, held against rotation by the reaction arms or plates 27. Since the upper coupling assembly 29 has been disengaged from the auger, the auger can move freely through it. The auger therefore continues to rotate and move downwards as it continues to penetrate the soil, while the casing and its attached upper assembly 29 remain in position with no further rotation or downward movement.

After the auger has reached the required depth, concrete is pumped through shaft 15 of the auger which is withdrawn at a controlled rate such that no void is created. For the initial part of this process, the casing 25 remains in position. When the sockets 35 of the auger rise to the level of the apertures 36 at the upper end of the casing, however, the concreting process is interrupted. Withdrawal of the auger is halted, and the upper coupling assembly 29 is coupled again to the auger by means of the bars 37. (A slight rotation or vertical adjustment of the auger may be required, to align the sockets 35 with the mounting apertures 36.)

Withdrawal of the auger and injection of concrete is then restarted. This results in the withdrawal of the casing 25, which is carried up by the auger by means of the upper assembly 29. As the auger and casing are withdrawn, so concrete is being injected into the pile under positive pressure; hence there is

no collapse of the soil in the unstable soil layer into the pile during this process. The rate of concrete injection is preferably increased slightly, to allow for the slightly greater diameter of the hole in the region where the casing was.

Once the auger has been fully withdrawn, the pin 34 is withdrawn (if it was not withdrawn earlier), and the auger is rotated again in the casing to clear spoil from the region of the auger inside the casing. The auger can of course be rotated in either direction for this. However rotation in the opposite direction (to that used for screwing the auger into the ground) may be more effective in clearing the spoil, but will require the auger drive unit 13 to have bi-directional drive.

Claims

1 A method of constructing a pile in soil having an unstable upper layer by installing into the soil an auger having a continuous flight and a hollow central shaft and inserting into the soil a casing which is held against rotation as the auger is rotated, and then removing the auger while pumping concrete through its shaft, wherein the casing is coupled at its top end to the auger for lowering through the unstable soil layer and then uncoupled therefrom.

2 A method according to claim 1 wherein the casing is coupled again to the auger during the removal of the auger.

3 A method of making a pile substantially as herein described with reference to the drawings.

4 Pile forming apparatus comprising an auger, a casing surrounding the lower end of the auger, a coupling device mounted at the top of the casing via a ring bearing, and means for attaching the coupling device to the auger.

5 Apparatus according to claim 4 including a locking device for locking the coupling device to the casing,

6 Apparatus according to claim 5 wherein the locking devices comprise a pin and holes in the coupling device and the top end of the casing.

7 Apparatus according to any of claims 4 to 6 wherein the attachment means comprise mounting means formed on the coupling device, socket means

mounted on the auger flight, and bar means insertable through the mounting means into the socket means.

8 Apparatus according to claim 7 wherein the attachment means also include pin means for holding the bar means in the socket means.

9 Pile forming apparatus substantially as herein described with reference to the drawings.

10 Any novel and inventive feature or combination of features specifically disclosed herein within the meaning of Article 4H of the International Convention (Paris Convention).

The Patent Office

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Application No:	GB 9925721.4	**Examiner:**	R L Williams
Claims searched:	1-10	**Date of search:**	1 March 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): E1H (HGJ)

Int Cl (Ed.7): E02D 5/34,5/36

Other: EPODOC,WPI,JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2,303,868 A	Cementation Piling & Foundations Limited	-
A	EP 0,012,486 A1	Hollandsche Beton Groep N V	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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